

September 1997

Preliminary Data Summary

by Field Research Facility

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at
<http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and suggestions are welcome.

Introduction

1

The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

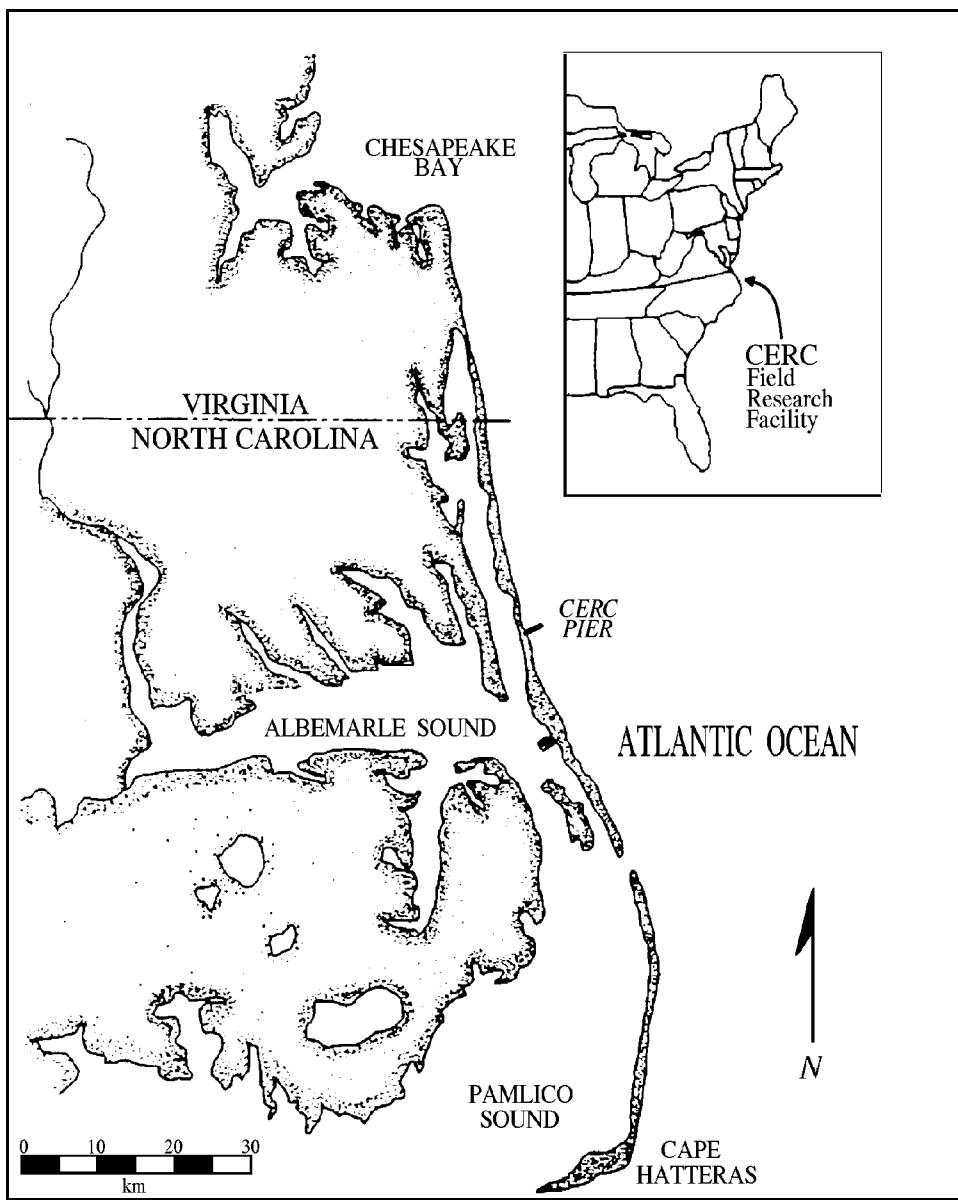


Figure 1. FRF Location Map

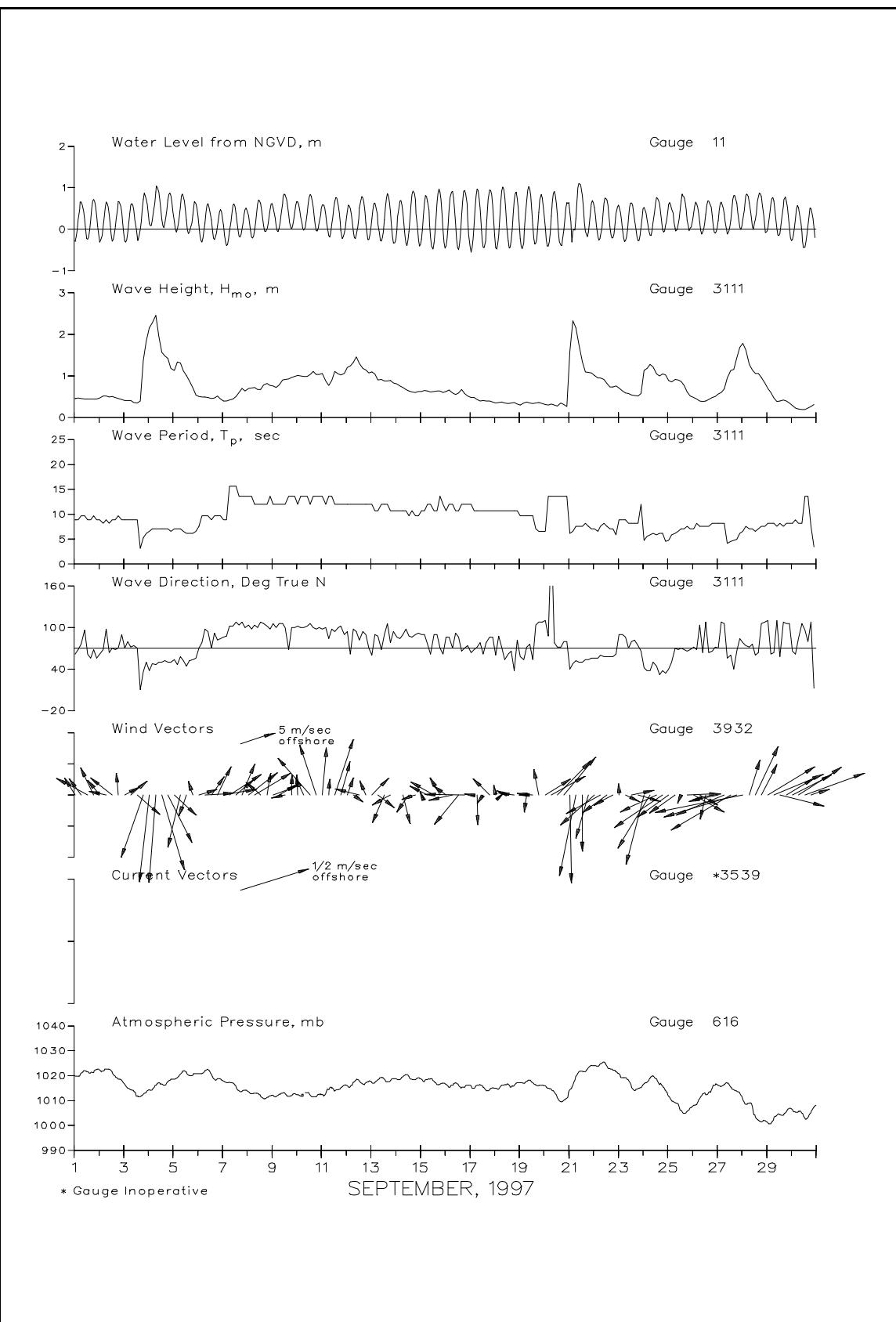


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		September 1997																																
		Day of the month																																
Gauge	ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0		
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																											
Data Collected		*	= All	/	= Partial	-	= None																											
Visual Observations		*	= Complete	/	= Partial	-	= None																											

Table 2
Gauge Locations

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		* Degrees N	* Degrees W	* Crossshore	T Longshore*	NGVD, m
		*	*	*	m	NGVD, m
616	* Atmospheric Pressure*	36 10' 57.03"	* 75 45' 5.50"	* 11.60	* 569.00	* -----
	*	*	*	*	*	*
3932	* Anemometer	* 36 11' 1.23"	* 75 44' 43.07"	* 585.20	* 517.30	* 19.50
	*	*	*	*	*	*
641	* Pressure Gauge	* 36 10' 57.71"	* 75 44' 56.23"	* 239.11	* 516.64	* -1.64
	*	*	*	*	*	*
625	* Baylor Staff	* 36 11' 1.04"	* 75 44' 43.72"	* 568.00	* 516.64	* Surface
	*	*	*	*	*	-8.36
3111	* 8 Meter Array North	* 36 11' 19.14"	* 75 44' 36.41"	* 915.23	* 990.16	* -7.50
	*	*	*	*	*	-7.90
	* 8 Meter Array South	* 36 11' 11.28"	* 75 44' 33.28"	* 914.20	* 735.37	* -7.42
	*	*	*	*	*	-7.90
	* 8 Meter Array East	* 36 11' 13.70"	* 75 44' 32.56"	* 954.51	* 800.58	* -7.62
	*	*	*	*	*	-8.13
	* 8 Meter Array West	* 36 11' 12.48"	* 75 44' 37.11"	* 834.66	* 800.37	* -6.98
	*	*	*	*	*	-7.44
111	* Pressure Gauge in center of 8 M Array	* 36 11' 14.06"	* 75 44' 34.39"	* 914.43	* 825.52	* -7.76
	*	*	*	*	*	*
630	* Waverider Buoy	* 36 10' 5.10"	* 75 41' 59.30"	* 3934.96	* -2400.81	* Surface
	*	*	*	*	*	-17.00
3539	* Current Meter	* 36 11' 23.57"	* 75 44' 9.12"	* 1605.80	* 907.60	* -11.60
	*	*	*	*	*	-11.70
11	* NOAA Tide Gauge	* 36 11' 1.25"	* 75 44' 42.60"	* 596.49	* 514.20	* Surface
	*	*	*	*	*	-7.62
R	R	R	R	R	R	R

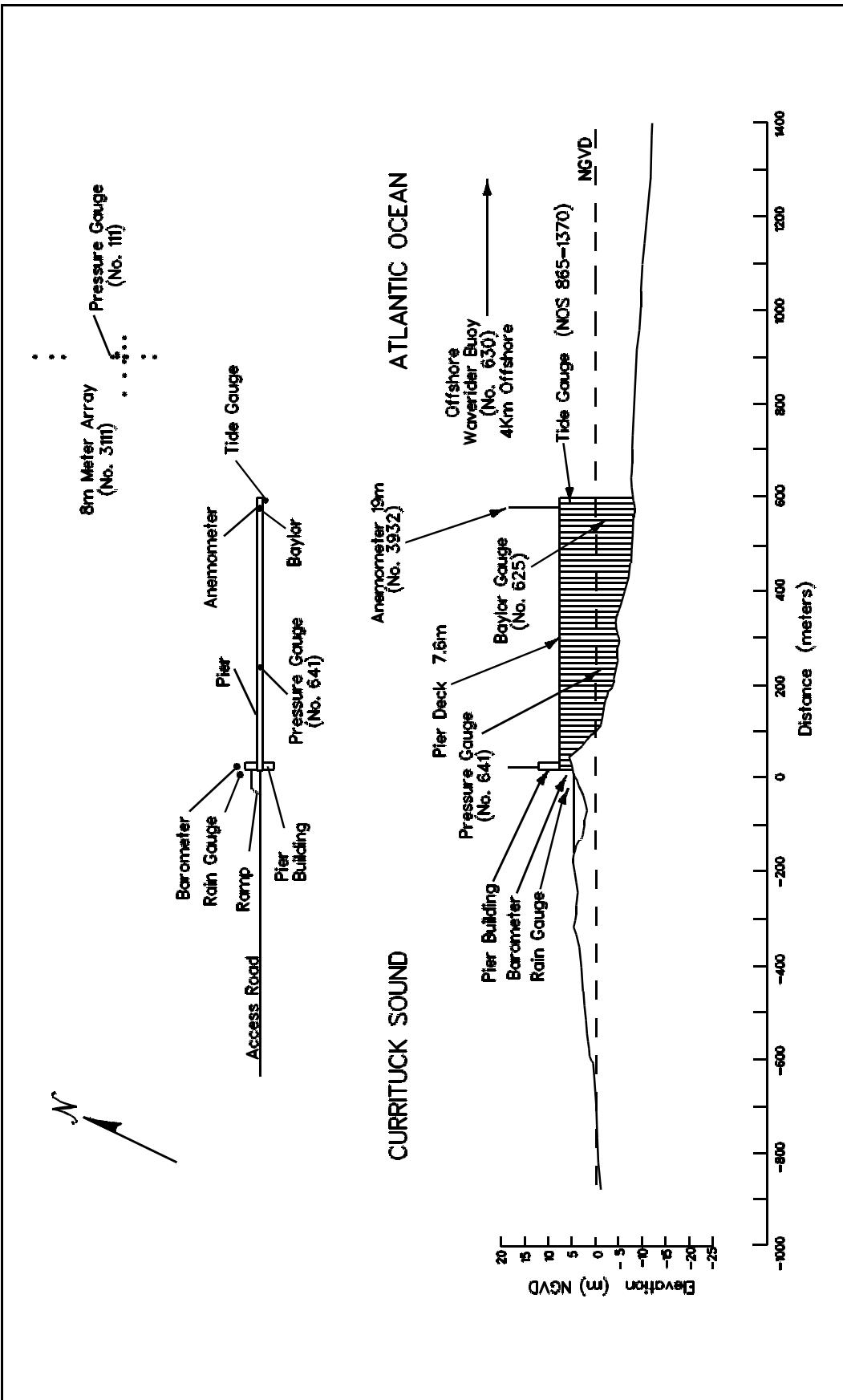


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

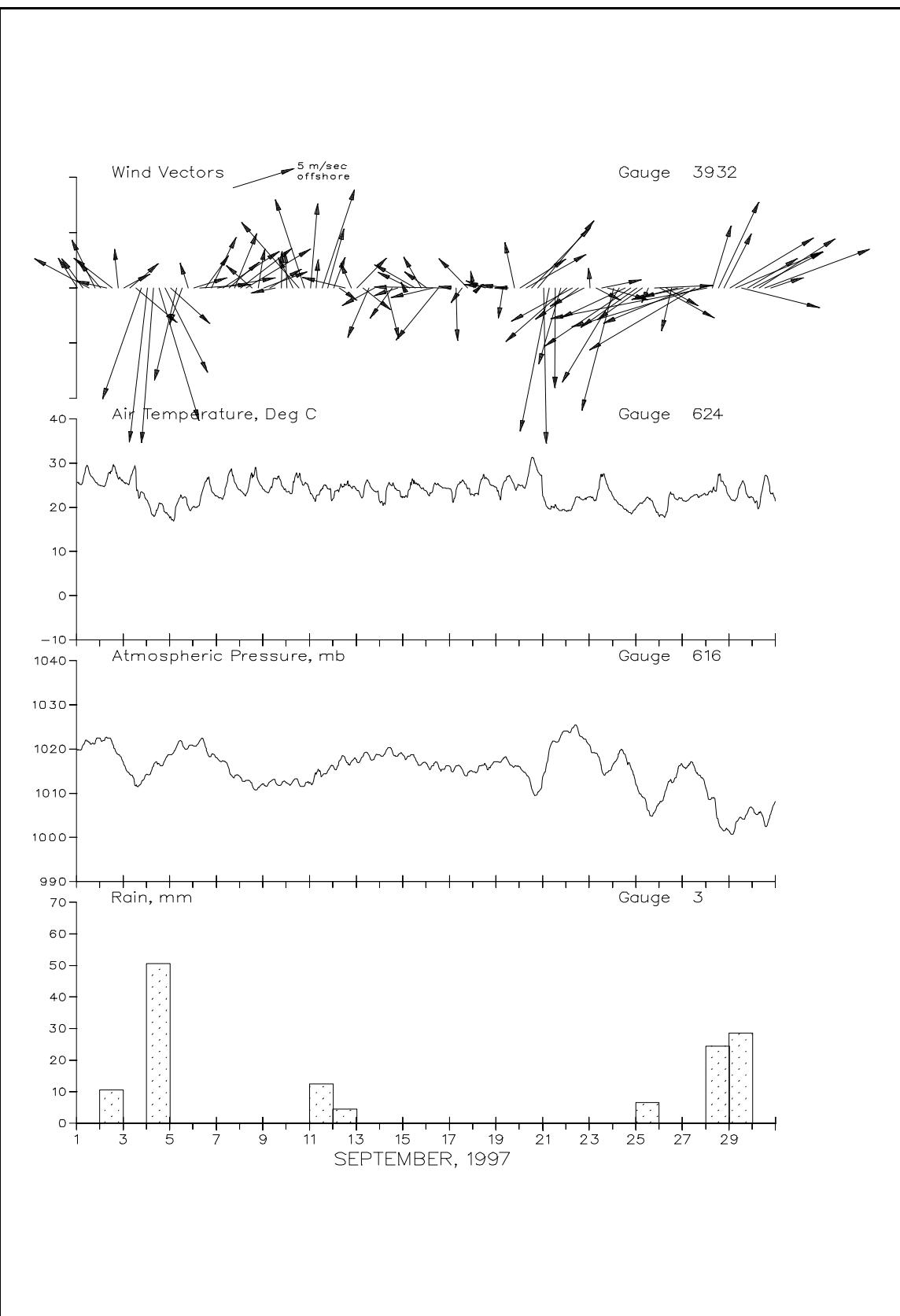


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Sep 1997						
		Wind Speed	Wind Direction	Temperature	Atm Pressure	Precipitation
Day	Hour	m/sec	deg TN	deg C	mb	mm
1	100	3	151	25.7	1019.8	0
	700	3	147	26.1	1021.0	0
	1300	5	121	28.2	1021.7	0
	1900	5	157	25.8	1021.3	0
2	100	3	143	24.9	1022.2	0
	700	2	104	26.0	1022.7	10
	1300	4	131	28.6	1021.4	0
	1900	3	175	26.5	1018.7	0
3	100	2	238	25.7	1016.5	0
	700	3	225	26.1	1014.3	0
	1300	4	314	28.5	1011.7	0
	1900	10	16	23.5	1012.5	0
4	100	14	5	21.6	1014.3	0
	700	14	3	18.3	1016.2	50
	1300	12	345	20.9	1016.7	0
	1900	8	336	18.9	1017.5	0
5	100	4	316	17.9	1018.7	0
	700	9	11	20.6	1020.6	0
	1300	3	16	22.1	1021.4	0
	1900	2	164	20.2	1020.3	0
6	100	3	250	20.1	1020.8	0
	700	4	265	21.1	1021.9	0
	1300	3	211	25.8	1020.6	0
	1900	5	202	23.8	1018.8	0
7	100	5	258	22.5	1017.9	0
	700	5	232	22.0	1017.4	0
	1300	3	225	27.7	1015.6	0
	1900	5	199	25.6	1013.8	0
8	100	5	228	23.8	1013.6	0
	700	6	234	23.0	1013.0	0
	1300	3	134	26.7	1011.9	0
	1900	4	188	26.0	1011.3	0
9	100	4	246	24.1	1012.1	0
	700	3	235	23.9	1012.6	0
	1300	2	75	26.5	1012.8	0
	1900	3	180	25.2	1012.1	0
10	100	3	177	23.5	1012.3	0
	700	3	157	25.0	1012.7	0
	1300	7	142	27.1	1012.1	0
	1900	8	164	25.3	1011.7	0

Table 3
Meteorological Data (continued)

Sep 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	8	184	23.1	1012.4	0
	700	3	182	22.4	1014.3	12
	1300	9	195	24.3	1014.0	0
	1900	5	1	24.2	1015.1	0
12	100	3	197	22.1	1016.0	0
	700	2	310	24.1	1017.4	5
	1300	3	105	25.2	1017.7	0
	1900	2	159	24.5	1017.1	0
13	100	3	220	23.9	1017.2	0
	700	3	312	22.4	1018.4	0
	1300	5	20	25.5	1018.7	0
	1900	3	57	23.6	1018.1	0
14	100	7	28	21.0	1018.6	0
	700	5	347	23.6	1019.7	0
	1300	3	31	24.9	1019.7	0
	1900	2	68	23.8	1018.5	0
15	100	1	158	22.2	1018.6	0
	700	3	119	24.1	1018.4	0
	1300	4	122	25.4	1017.9	0
	1900	3	153	24.3	1016.5	0
16	100	2	129	23.5	1016.7	0
	700	3	74	24.1	1016.3	0
	1300	6	35	25.2	1016.2	0
	1900	5	90	24.4	1015.5	0
17	100	1	98	24.2	1015.9	0
	700	5	1	23.9	1016.2	0
	1300	2	31	26.0	1015.5	0
	1900	3	139	24.2	1014.4	0
18	100	2	171	22.8	1014.9	0
	700	0		24.4	1016.2	0
	1300	2	112	26.7	1016.5	0
	1900	2	98	25.1	1016.2	0
19	100	0		24.2	1017.1	0
	700	3	7	25.0	1017.8	0
	1300	2	96	27.0	1017.1	0
	1900	4	169	24.8	1016.0	0
20	100	4	234	24.8	1016.0	0
	700	6	237	25.1	1014.5	0
	1300	7	220	31.3	1011.1	0
	1900	7	215	28.2	1010.2	0

Table 3
Meteorological Data (concluded)

Sep 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	14	359	22.2	1014.3	0
	700	13	9	19.7	1019.9	0
	1300	9	1	20.6	1021.8	0
	1900	7	14	19.2	1023.2	0
22	100	7	44	19.1	1024.1	0
	700	6	57	20.1	1024.8	0
	1300	4	49	22.2	1023.9	0
	1900	3	58	21.8	1022.3	0
23	100	2	176	22.4	1020.7	0
	700	2	300	21.6	1019.1	0
	1300	3	257	26.9	1015.5	0
	1900	3	1	25.0	1014.8	0
24	100	11	12	22.2	1016.8	0
	700	10	27	20.7	1019.1	0
	1300	6	61	19.6	1018.8	0
	1900	9	51	18.7	1015.9	0
25	100	6	50	20.1	1011.8	0
	700	5	50	20.8	1009.2	7
	1300	1	20	22.2	1006.1	0
	1900	5	267	20.0	1005.7	0
26	100	5	302	18.3	1008.1	0
	700	3	303	18.4	1010.8	0
	1300	4	11	22.9	1012.5	0
	1900	3	72	21.7	1014.9	0
27	100	4	75	21.5	1016.2	0
	700	7	64	21.9	1016.7	0
	1300	10	55	22.8	1015.4	0
	1900	11	70	22.7	1013.8	0
28	100	12	77	22.9	1010.5	0
	700	6	194	23.4	1009.0	24
	1300	8	202	27.5	1003.6	0
	1900	5	203	25.2	1001.6	0
29	100	8	235	22.2	1001.1	0
	700	8	244	21.6	1003.1	29
	1300	6	1	25.3	1004.4	0
	1900	5	235	22.7	1005.7	0
30	100	6	239	22.1	1006.4	0
	700	7	233	20.1	1005.8	0
	1300	9	246	27.1	1002.9	0
	1900	3	250	23.0	1005.4	0
		Resultant		Mean	Mean	Total
		—	1	53	23.5	1015.3
						137

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Sep 1997										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
1	0100	0.20	8.9	0.44	8.9	0.45	8.9	62	0.55	8.4
	0700	0.28	8.6	0.40	8.6	0.46	9.8	76	0.52	8.4
	1300	0.21	8.9	0.47	9.5	0.45	8.9	62	0.50	9.1
	1900	0.27	8.9	0.44	9.2	0.44	9.8	68	0.53	9.1
2	0100	0.19	9.9	0.46	10.3	0.46	8.9	62	0.50	10.1
	0700	0.30	8.9	0.45	8.3	0.52	8.9	98	0.62	8.4
	1300	0.23	8.9	0.48	9.5	0.50	8.9	70	0.57	9.1
	1900	0.25	8.1	0.42	8.6	0.45	9.8	70	0.54	10.1
3	0100	0.18	8.6	0.42	8.9	0.41	8.9	70	0.52	6.7
	0700	0.22	17.1	0.38	8.3	0.41	8.9	72	0.46	9.1
	1300	0.15	16.0	0.33	8.6	0.34	8.9	70	0.40	8.4
	1900	0.87	5.0	1.09	5.1	1.37	5.3	36	1.09	4.8
4	0100	1.48	6.8	1.97	6.8	2.16	6.6	38	2.30	6.3
	0700	1.80	7.0	2.27	7.2	2.46	7.1	46	2.64	6.7
	1300	1.36	7.4	1.48	7.4	1.57	7.1	50	1.88	7.7
	1900	1.22	7.2	1.31	7.2	1.42	7.1	50	1.84	6.7
5	0100	0.96	6.3	1.07	7.4	1.13	7.1	54	1.38	5.9
	0700	1.07	6.5	1.23	6.5	1.32	7.1	58	1.45	7.2
	1300	0.81	6.1	0.97	7.0	1.02	6.2	44	1.27	7.2
	1900	0.54	6.1	0.69	6.3	0.71	6.2	54	0.87	6.3
6	0100	0.27	6.3	0.45	10.7	0.50	7.6	70	0.65	5.9
	0700	0.24	9.9	0.48	9.9	0.50	9.8	98	0.53	9.1
	1300	0.20	9.5	0.41	9.5	0.46	8.9	70	0.52	10.6
	1900	0.26	9.5	0.49	9.5	0.51	9.8	82	0.69	3.8
7	0100	0.20	9.2	0.42	9.2	0.39	8.9	86	0.56	8.4
	0700	0.18	8.9	0.33	8.6	0.42	15.7	102	0.52	16.7
	1300	0.25	15.1	0.44	15.1	0.50	15.7	108	0.54	15.4
	1900	0.37	14.3	0.64	14.3	0.70	13.6	108	0.77	13.4
8	0100	0.37	12.9	0.57	12.9	0.69	13.6	104	0.84	13.4
	0700	0.43	12.9	0.72	12.9	0.73	12.0	104	0.84	12.6
	1300	0.40	12.2	0.58	12.2	0.67	12.0	108	0.70	11.8
	1900	0.55	12.2	0.86	12.2	0.82	12.0	102	0.95	12.6
9	0100	0.49	12.9	0.75	12.9	0.76	12.0	106	0.91	12.6
	0700	0.40	11.7	0.66	11.7	0.79	12.0	106	0.79	11.8
	1300	0.69	12.9	0.90	11.7	0.92	12.0	100	0.99	11.2
	1900	0.64	13.5	0.89	13.5	0.97	13.6	100	1.09	14.3
10	0100	0.72	12.9	0.85	12.2	1.00	12.0	102	1.23	12.6
	0700	0.64	12.9	0.96	12.9	0.99	13.6	100	1.13	13.4
	1300	0.74	12.9	0.94	12.9	1.03	12.0	106	1.13	10.1
	1900	0.61	4.9	1.01	9.9	1.04	13.6	98	1.23	10.1

Table 4
Wave Data (continued)

Sep 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
11	0100	0.63	12.2	0.92	12.9	1.06	13.6	98	1.29	14.3	
	0700	0.40	12.2	0.68	12.2	0.77	13.6	84	0.92	12.6	
	1300	0.67	12.9	1.01	12.9	1.11	12.0	94	1.29	12.6	
	1900	0.58	13.5	0.99	12.2	1.02	12.0	102	1.20	11.8	
12	0100	0.68	12.2	1.04	12.2	1.20	12.0	94	1.17	11.8	
	0700	0.69	12.9	1.14	11.7	1.32	12.0	98	1.31	12.6	
	1300	0.79	11.7	1.20	11.7	1.30	12.0	82	1.23	11.2	
	1900	0.56	11.7	0.96	11.7	1.14	12.0	90	1.29	12.6	
13	0100	0.59	11.7	1.01	11.7	1.10	12.0	60	1.14	11.2	
	0700	0.47	11.2	0.90	11.7	0.91	10.8	88	0.99	11.2	
	1300	0.49	10.7	0.81	11.7	0.87	12.0	90	0.95	11.8	
	1900	0.45	11.2	0.76	11.2	0.89	10.8	78	0.99	11.2	
14	0100	0.40	9.9	0.75	9.9	0.81	10.8	86	0.86	10.1	
	0700	0.37	11.2	0.67	9.9	0.72	10.8	90	0.73	11.2	
	1300	0.34	11.2	0.72	11.2	0.64	9.8	88	0.76	10.6	
	1900	0.37	10.7	0.56	10.7	0.61	9.8	90	0.70	11.2	
15	0100	0.31	11.2	0.66	10.7	0.63	10.8	90	0.61	10.1	
	0700	0.38	11.7	0.56	11.7	0.64	12.0	76	0.65	11.8	
	1300	0.30	13.5	0.66	11.2	0.63	10.8	90	0.68	11.2	
	1900	0.38	12.2	0.60	10.3	0.63	13.6	70	0.72	10.6	
16	0100	0.29	12.9	0.61	11.2	0.63	10.8	86	0.65	12.6	
	0700	0.39	11.2	0.62	12.2	0.59	12.0	70	0.64	11.2	
	1300	0.34	11.7	0.61	10.7	0.59	10.8	86	0.68	10.6	
	1900	0.41	11.7	0.62	12.2	0.58	12.0	70	0.74	12.6	
17	0100	0.23	11.2	0.48	11.2	0.49	12.0	64	0.55	10.6	
	0700	0.28	10.3	0.44	10.7	0.43	10.8	72	0.51	10.6	
	1300	0.19	10.7	0.38	10.7	0.41	10.8	62	0.43	10.6	
	1900	0.27	10.3	0.44	10.3	0.39	10.8	86	0.48	11.2	
18	0100	0.17	10.7	0.37	10.7	0.34	10.8	60	0.40	10.6	
	0700	0.22	10.3	0.34	10.3	0.37	10.8	72	0.40	10.5	
	1300	0.15	11.2	0.37	11.2	0.33	10.8	62	0.37	10.6	
	1900	0.23	10.3	0.34	9.9	0.36	10.8	38	0.42	10.1	
19	0100	0.18	10.7	0.40	10.3	0.30	9.8	58	0.38	10.6	
	0700	0.23	9.9	0.35	9.9	0.37	9.8	72	0.40	10.6	
	1300	0.19	7.2	0.32	7.2	0.33	9.8	54	0.37	9.1	
	1900	0.25	6.6	0.39	6.1	0.36	6.6	108	0.47	5.9	
20	0100	0.18	6.8	0.31	13.5	0.31	6.6	110	0.37	6.7	
	0700	0.18	14.3	0.27	14.3	0.32	13.6	246	0.36	6.3	
	1300	0.16	13.5	0.24	14.3	0.28	13.6	72	0.40	13.4	
	1900	0.19	13.5	0.32	13.5	0.32	13.6	80	0.54	2.8	

Table 4
Wave Data (concluded)

Sep 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
21	0100	0.93	5.0	1.14	4.7	1.59	6.2	40	1.21	4.4	
	0700	1.58	7.4	1.97	7.2	2.16	7.6	52	2.47	7.2	
	1300	1.26	7.6	1.31	8.1	1.34	7.6	50	1.71	6.7	
	1900	0.86	6.6	1.02	7.8	1.09	7.6	54	1.31	7.7	
22	0100	0.78	7.0	1.00	7.4	1.02	7.1	56	1.26	7.2	
	0700	0.69	6.0	0.98	7.6	0.95	7.6	60	1.11	6.3	
	1300	0.57	7.4	0.83	7.6	0.81	7.6	58	0.92	7.7	
	1900	0.47	5.5	0.76	6.6	0.74	7.1	58	0.90	6.7	
23	0100	0.44	5.4	0.75	9.2	0.71	8.9	90	0.86	9.1	
	0700	0.28	4.5	0.64	8.9	0.59	8.9	86	0.67	8.4	
	1300	0.31	13.5	0.53	8.3	0.54	8.2	80	0.57	8.4	
	1900	0.23	12.9	0.51	12.9	0.51	8.2	74	0.53	7.7	
24	0100	0.82	4.3	0.98	4.2	1.14	4.8	42	1.15	4.1	
	0700	1.03	5.6	1.16	5.5	1.28	5.9	38	1.44	5.6	
	1300	0.95	6.3	0.94	5.9	1.04	5.9	44	1.30	6.3	
	1900	0.87	5.9	1.01	5.9	1.05	6.2	38	1.07	6.3	
25	0100	0.73	4.9	0.88	4.7	0.89	4.8	40	1.08	5.1	
	0700	0.62	5.7	0.90	5.7	0.92	6.2	70	1.09	5.9	
	1300	0.55	6.6	0.77	6.8	0.87	7.1	70	0.98	6.7	
	1900	0.33	8.3	0.60	8.3	0.62	7.6	66	0.79	6.7	
26	0100	0.29	7.8	0.46	7.4	0.47	7.1	72	0.67	7.2	
	0700	0.23	8.6	0.39	7.8	0.40	7.6	104	0.51	7.7	
	1300	0.25	7.2	0.37	8.1	0.40	7.6	108	0.48	8.4	
	1900	0.34	8.1	0.46	7.8	0.48	8.2	66	0.58	7.7	
27	0100	0.38	8.3	0.50	8.3	0.56	8.2	70	0.68	8.4	
	0700	0.47	3.5	0.68	8.6	0.69	8.2	106	0.85	8.4	
	1300	0.80	4.3	1.09	4.2	1.13	4.6	60	1.31	4.2	
	1900	0.90	4.9	1.25	4.9	1.43	5.0	66	1.57	5.1	
28	0100	1.02	6.8	1.75	6.1	1.79	6.6	78	2.05	6.3	
	0700	0.83	7.2	1.33	7.4	1.28	7.1	72	1.79	7.2	
	1300	0.67	6.6	1.05	7.0	1.06	6.6	60	1.52	6.7	
	1900	0.66	7.2	0.96	7.6	0.96	7.6	106	1.35	8.4	
29	0100	0.46	8.9	0.71	9.2	0.70	8.2	110	0.97	8.4	
	0700	0.33	8.1	0.44	8.3	0.46	8.2	64	0.76	7.2	
	1300	0.24	8.1	0.38	8.9	0.39	8.2	58	0.61	7.7	
	1900	0.26	8.3	0.37	7.2	0.40	8.2	106	0.57	7.7	
30	0100	0.16	8.6	0.29	8.1	0.28	8.2	66	0.43	9.1	
	0700	0.13	9.2	0.17	7.4	0.21	8.2	84	0.30	9.1	
	1300	0.10	8.1	0.19	8.1	0.19	13.6	96	0.37	8.4	
	1900	0.16	12.9	0.24	12.9	0.27	7.6	108	0.33	12.6	
Mean		0.49	9.5	0.72	9.5	0.77	9.6	78	0.89	9.2	
Std dev		0.33	2.9	0.38	2.5	0.42	2.5	25	0.46	2.7	

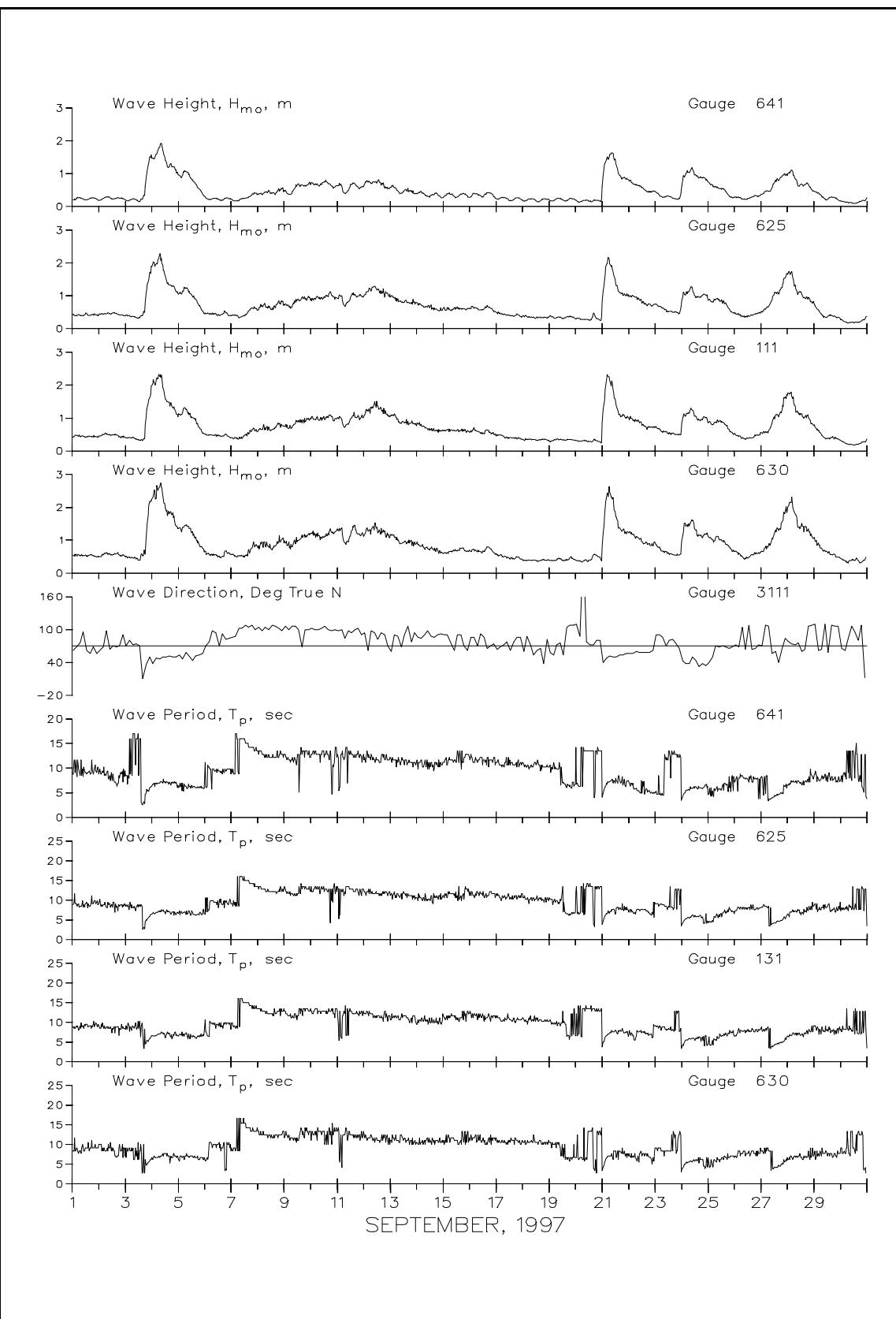


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

SEPTEMBER 1997																	
		Cross	Long		Cross	Long		Cross	Long								
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100					11	100					21	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
2	100	Data				12	100	Data				22	100	Data			
	700						700						700				
	1300	presently					1300	presently					1300	presently			
	1900						1900						1900				
3	100	unavailable.				13	100	unavailable.				23	100	unavailable.			
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
4	100					14	100					24	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
5	100					15	100					25	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
6	100					16	100					26	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
7	100					17	100					27	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
8	100	Data				18	100	Data				28	100	Data			
	700						700						700				
	1300	presently					1300	presently					1300	presently			
	1900						1900						1900				
9	100	unavailable.				19	100	unavailable.				29	100	unavailable.			
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				
10	100					20	100					30	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Sep 1997												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	-20	20	340	8	-17	19	7	South	40	S	
2	-8	-17	19	316	-30	-51	59	309	South	29	N	
3	7	-20	22	359	-6	-41	41	331	South	10	N	
4	-37	122	127	177	-183	305	355	191	South	143	N	
5	-13	44	45	177	-44	87	97	187	South	62	N	
6	22	-29	36	17	-5	-47	47	334	North	24	N	
7	21	-17	27	30	7	-47	47	349	no observation			
8	7	-15	17	7	-15	-102	103	331	South	55	N	
9	0	0	0		-27	-61	67	316	North	38	S	
10	0	-6	6	340	0	-76	76	340	South	37	N	
11	-3	34	34	166	-37	-61	71	309	South	24	N	
12	0	0	0		-41	-68	79	309	South	25	S	
13	0	0	0		-37	-61	71	309	South	15	N	
14	-8	55	56	169	-2	-7	7	326	South	5	N	
15	-6	23	24	174	-3	22	22	169	South	5	N	
16	-6	8	10	197	-15	10	18	216	North	29	N	
17	-6	29	30	171	-8	18	20	184	North	8	N	
18	1	-6	6	346	0	0	0		South	4	N	
19	-7	12	14	191	-5	6	8	197	North	6	S	
20	20	-29	35	15	7	-12	15	11	North	4	S	
21	-39	87	95	184	-61	102	118	191	North	93	S	
22	-13	18	22	197	-20	44	48	184	North	18	S	
23	-1	14	14	163	14	-41	43	359	South	35	N	
24	-4	44	44	166	-20	102	104	171	North	29	S	
25	-7	19	20	179	9	-30	32	357	North	13	N	
26	5	6	8	118	8	-28	29	357	North	4	S	
27	0	0	0		18	-61	64	357	North	44	N	
28	6	-10	12	11	-13	-87	88	331	South	29	N	
29	11	-8	14	34	-10	-38	39	326	South	33	N	
30	19	-32	37	11	9	-19	21	4	South	6	S	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Water Characteristics at Pier End			
		Primary	Secondary	Surf Zone Width, m	Temp., C	Density	Secchi
						g/cc	Vis.,m
1	0925	70	110	27	24.7	1.0215	3.7
2	0656	80	145	38	24.4	1.0223	5.2
3	0708	110		31	24.4	1.0230	5.2
4	0624	10		85	23.1	1.0234	0.6
5	0630	5		75	22.2	1.0222	0.9
6	0635	60		46	23.3	1.0212	1.5
7	0705	85		52	23.3	1.0230	1.8
8	0615	90		68	23.3	1.0234	1.8
9	0700	80	150	37	23.9	1.0235	0.9
10	0702	95	30	73	24.4	1.0229	2.1
11	0716	130		68	23.9	1.0226	1.8
12	0755	115		71	23.3	1.0234	0.6
13	0550	120		63	23.6	1.0232	1.2
14	0627	100		51	23.9	1.0216	1.2
15	0621	20		32	23.9	1.0300	3.0
16	0635	135		26	23.9	1.0210	2.1
17	0657	10		9	24.2	1.0200	5.2
18	0648	130		7	24.4	1.0202	5.2
19	0645	110		18	24.7	1.0200	5.2
20	0734	130		7	24.4	1.0224	2.4
21	0811	5		44	22.8	1.0236	0.6
22	0643	15		26	22.2	1.0232	2.1
23	0703	130		29	23.1	1.0224	3.4
24	0711	10		30	22.2	1.0220	1.2
25	0707	110		26	21.7	1.0212	1.5
26	0653	20		26	21.9	1.0210	1.8
27	0808	110		23	22.5	1.0206	3.4
28	0808	110		49	22.2	1.0206	1.8
29	0703	125		10	22.2	1.0230	1.2
30	0650	40		10	22.2	1.0230	1.5

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

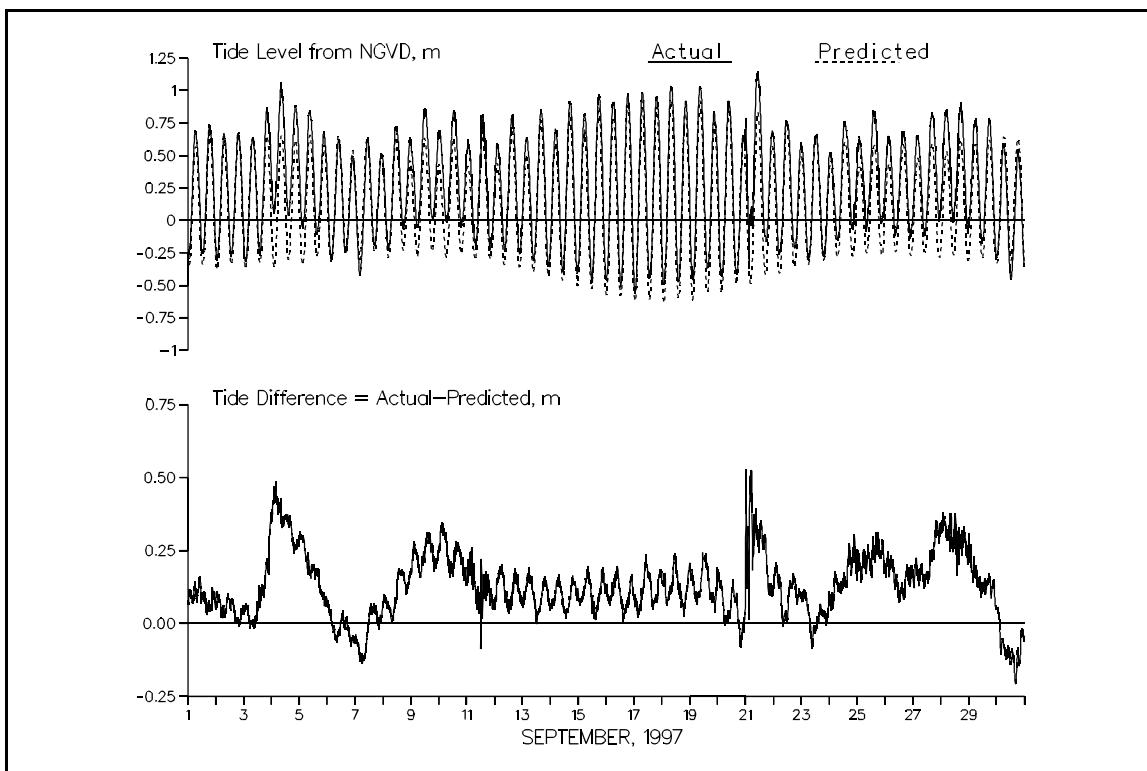


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

SEP 1997 Tide Levels																		
Day	High			Low			Mean	Range	High			Low			Mean	Range		
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day				
1	0612	0.69	1	0036	-0.30		0.25	0.99	16	0636	0.91	16	0024	-0.46	0.24	1.38		
1	1842	0.74	1	1248	-0.26		0.24	1.00	16	1830	0.98	16	1236	-0.51	0.24	1.49		
2	0712	0.67	2	0106	-0.32		0.18	0.99	17	0724	0.99	17	0048	-0.56	0.24	1.55		
2	1936	0.68	2	1312	-0.28		0.20	0.96	17	1924	0.96	17	1336	-0.45	0.26	1.40		
3	0812	0.64	3	0136	-0.32		0.16	0.96	18	0748	1.03	18	0124	-0.50	0.29	1.53		
3	2000	0.87	3	1400	-0.27		0.33	1.14	18	2030	0.93	18	1424	-0.48	0.23	1.40		
4	0806	1.07	4	0218	0.05		0.54	1.02	19	0900	1.03	19	0300	-0.46	0.30	1.50		
4	2024	0.88	4	1436	0.04		0.46	0.85	19	2100	0.84	19	1512	-0.37	0.23	1.21		
5	0900	0.85	5	0300	-0.07		0.38	0.91	20	0948	0.93	20	0324	-0.43	0.24	1.36		
5	2118	0.68	5	1530	-0.11		0.26	0.80	21	0042	0.79	20	1636	-0.42	0.15	1.21		
6	0936	0.62	6	0400	-0.30		0.16	0.93	21	1048	1.15	21	0306	-0.37	0.49	1.52		
6	2142	0.50	6	1548	-0.25		0.10	0.75	21	2300	0.69	21	1742	-0.17	0.26	0.86		
7	1024	0.62	7	0412	-0.43		0.11	1.04	22	1106	0.77	22	0518	-0.27	0.26	1.03		
7	2248	0.52	7	1706	-0.20		0.16	0.72	22	2354	0.60	22	1818	-0.22	0.18	0.81		
8	1106	0.72	8	0454	-0.24		0.25	0.96	23	1318	0.66	23	0618	-0.31	0.18	0.97		
8	2318	0.64	8	1736	-0.08		0.28	0.71	24	0100	0.52	23	1936	-0.28	0.13	0.80		
9	1236	0.86	9	0542	-0.06		0.40	0.92	24	1300	0.77	24	0712	-0.16	0.32	0.92		
10	0030	0.69	9	1836	0.00		0.35	0.69	25	0212	0.65	24	2018	-0.07	0.29	0.72		
10	1312	0.85	10	0700	-0.02		0.41	0.87	25	1400	0.85	25	0812	-0.08	0.40	0.93		
11	0136	0.63	10	1930	-0.06		0.28	0.68	26	0300	0.65	25	2100	-0.03	0.31	0.68		
11	1412	0.81	11	0754	-0.22		0.28	1.04	26	1512	0.69	26	0906	-0.13	0.30	0.81		
12	0212	0.59	11	2006	-0.23		0.20	0.82	27	0400	0.66	26	2148	-0.14	0.27	0.79		
12	1518	0.81	12	0842	-0.24		0.29	1.05	27	1618	0.83	27	0954	-0.12	0.37	0.96		
13	0324	0.64	12	2148	-0.26		0.20	0.90	28	0518	0.85	27	2300	-0.01	0.44	0.86		
13	1600	0.86	13	0936	-0.32		0.27	1.17	28	1718	0.91	28	1106	-0.02	0.45	0.93		
14	0430	0.71	13	2230	-0.35		0.19	1.06	29	0606	0.78	28	2330	-0.10	0.34	0.89		
14	1700	0.92	14	1036	-0.40		0.26	1.32	29	1754	0.79	29	1142	-0.18	0.29	0.97		
15	0530	0.82	14	2306	-0.41		0.21	1.23	30	0600	0.57	30	0012	-0.28	0.12	0.86		
15	1800	0.97	15	1200	-0.48		0.26	1.45	30	1836	0.55	30	1242	-0.45	0.04	1.00		

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in August and the survey(s) in September on profile line 188, located 517 m south of the pier.

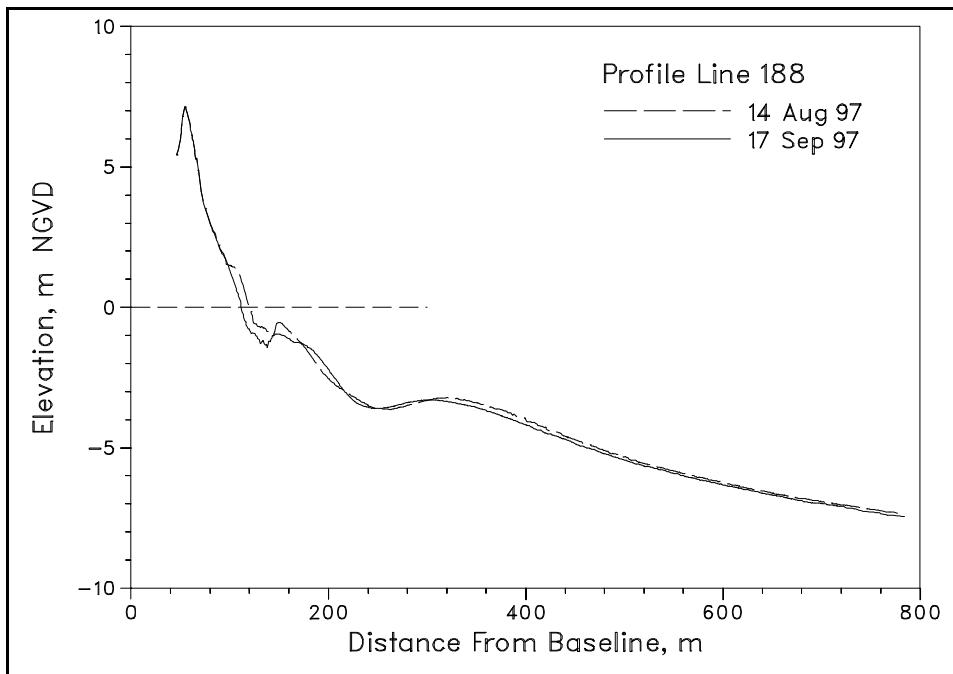


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in September.

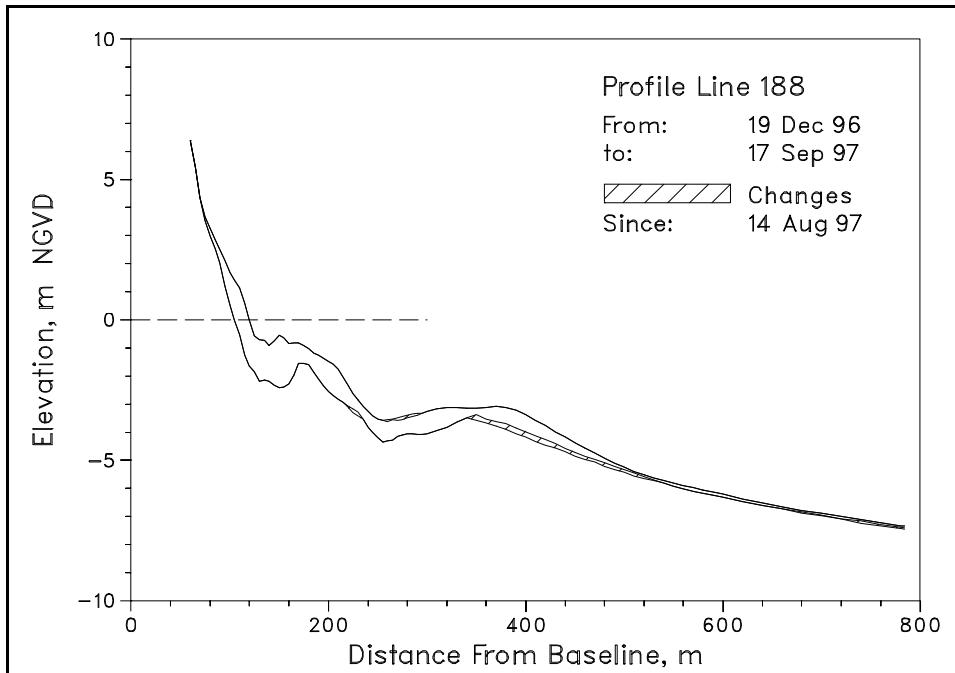
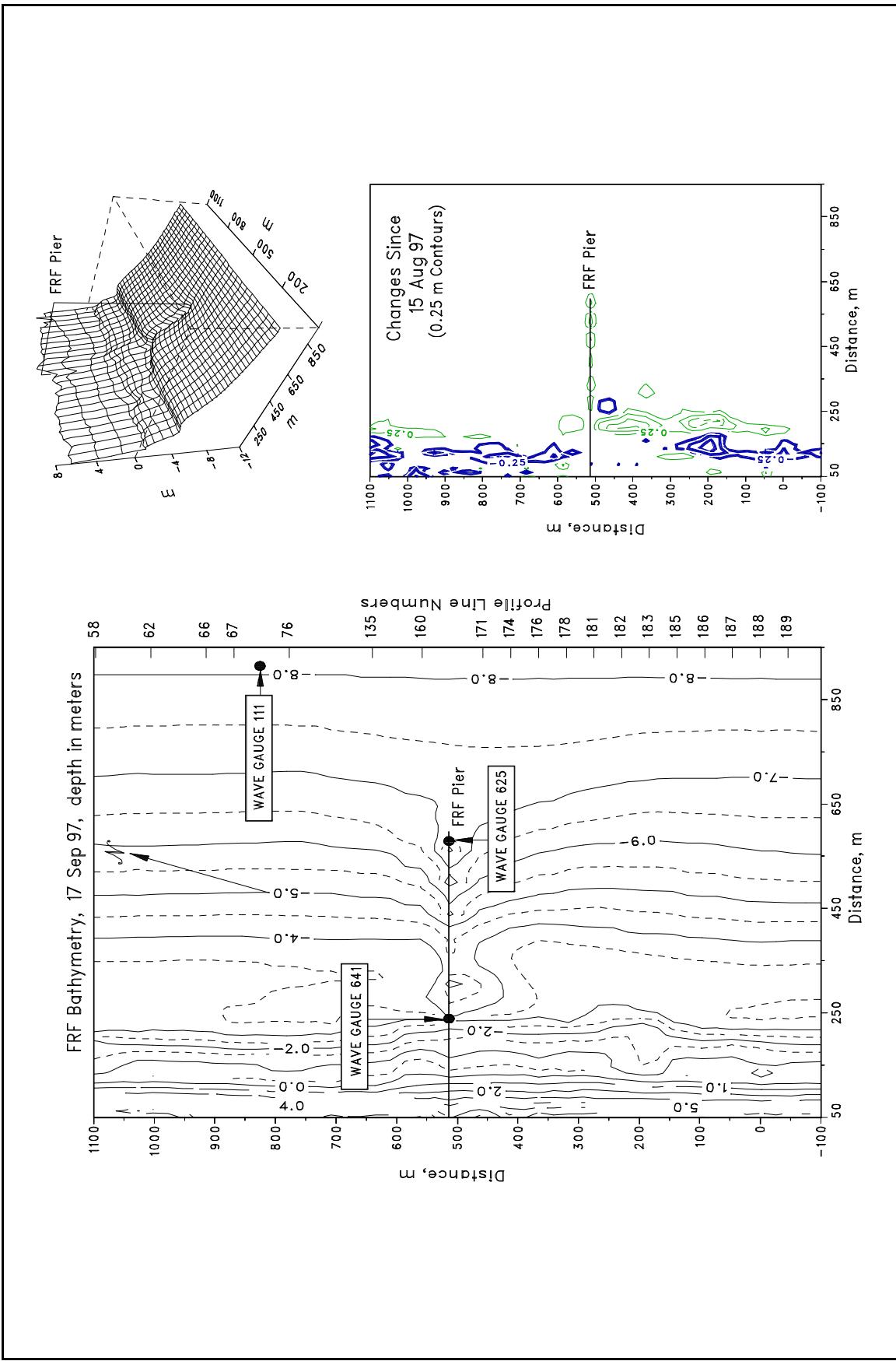


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 17 September. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
4 Sep (0100)	4 Sep (0808)

B. Storm Synopsis.

Northeasterly winds were funneled between a high pressure system, over the Great Lakes, and a low pressure system, off the South Carolina coast. Maximum onshore winds (NE) reached 9 m/s at 0134 EST. The maximum H_{mo} , at gauge 625, reached 2.3 m ($T_p=7.3$ s) at 0700 EST. There was 50 mm of precipitation.